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(54) Apparatus for elevating bulk material

(57) Apparatus (2) for elevating bulk material, comprises an endless conveyor belt (4) which is brought together over a part of its length with an elongate member (6) to define a closed duct (8) in which the bulk material is conveyed, the closed duct (8) being such that it bends in a first bend (14) in an upward direction for elevating the bulk material, the closed duct (8) being such that the endless conveyor belt (4) is situated on the outside of the first bend (14), at least one of the conveyor belt (4) and the elongate member (6) having transversely extending side walls (10, 12) which space the conveyor belt and the elongate member apart to define the closed duct, and the apparatus having a first concave surface (22) at the first bend whereby inward deformation of the conveyor belt that is on the outside of the first bend is substantially compensated for by the first concave surface so that the cross sectional area of the closed duct remains substantially constant along the length of the closed duct and substantial narrowing of the closed duct in the area of the first bend is avoided. The concave surface (22) may be formed in a guide drum 18 or in a series of rollers guiding the conveyor through the bend or in a fixed plate.

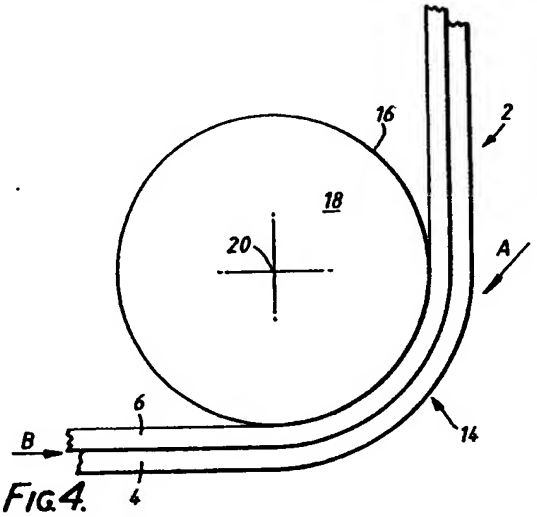

FIG.4.

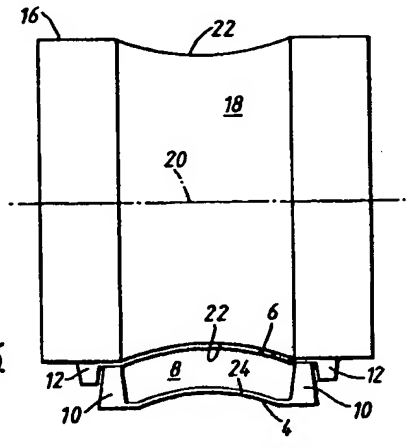

FIG.6.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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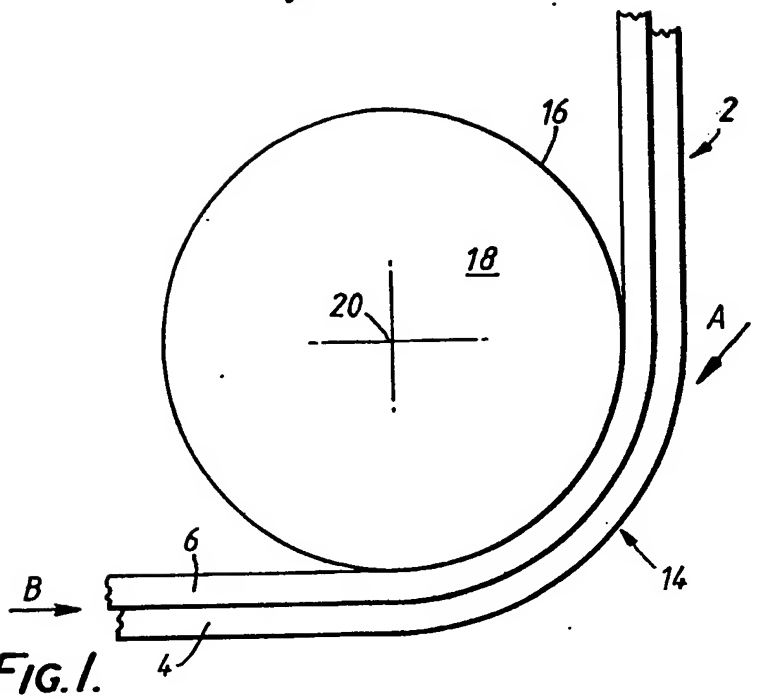

FIG. 1.

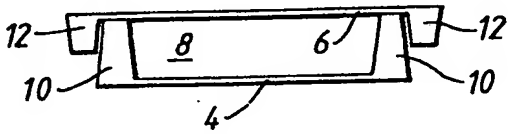

FIG. 2.

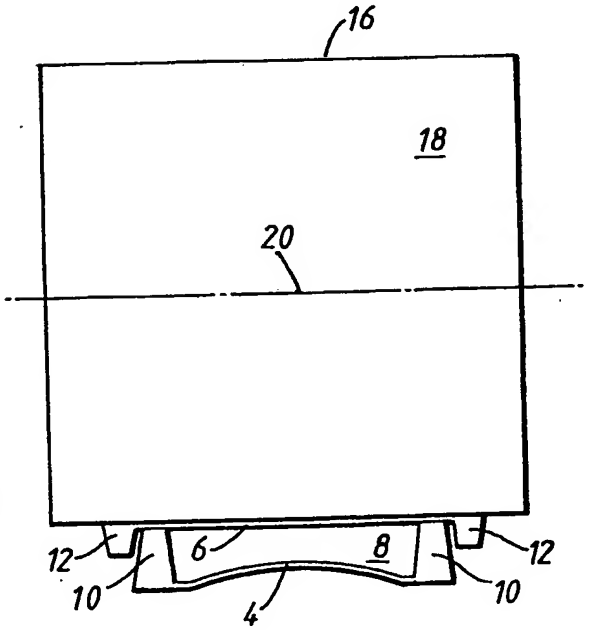

FIG. 3.

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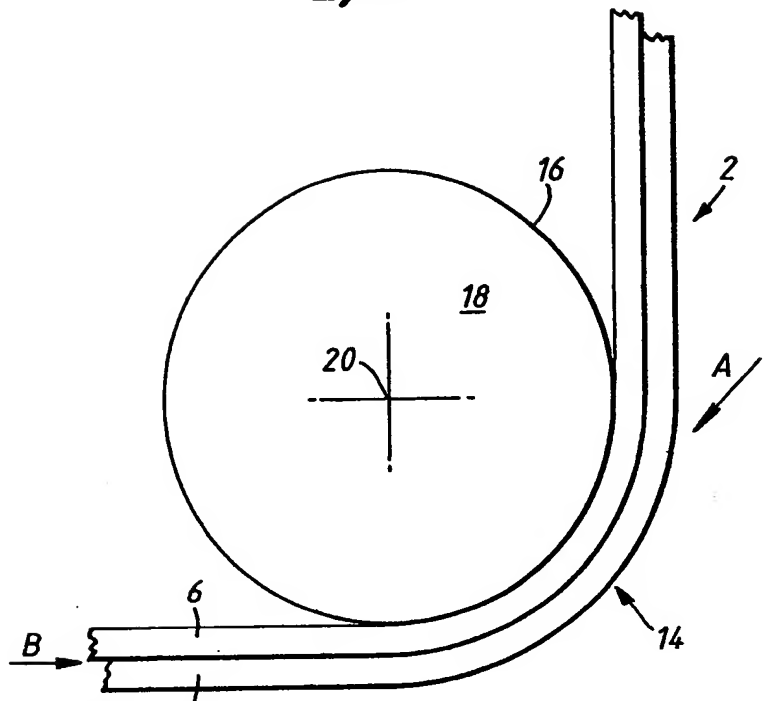

FIG.4.

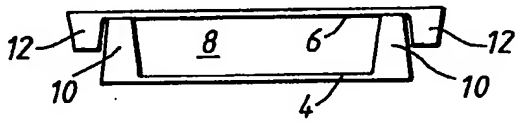

FIG.5.

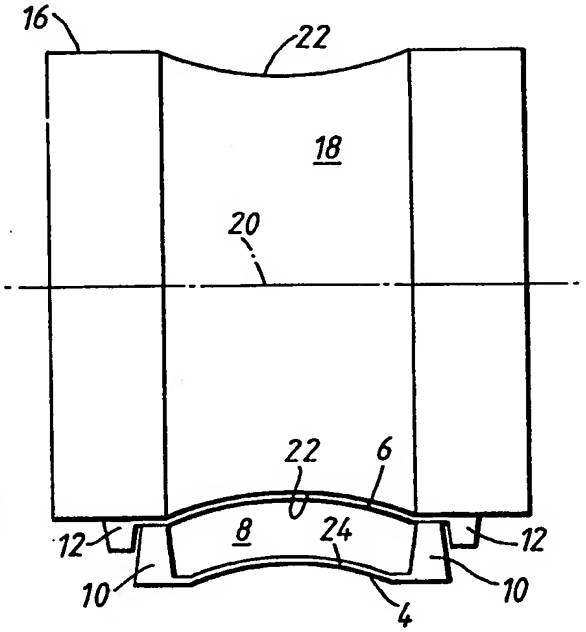

FIG.6.

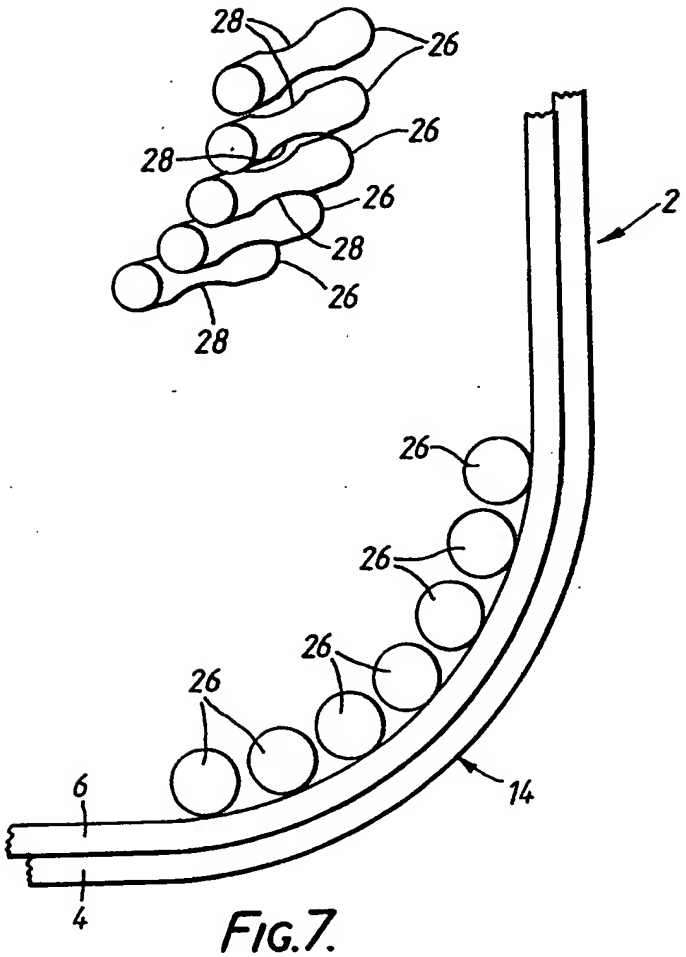

FIG. 7.

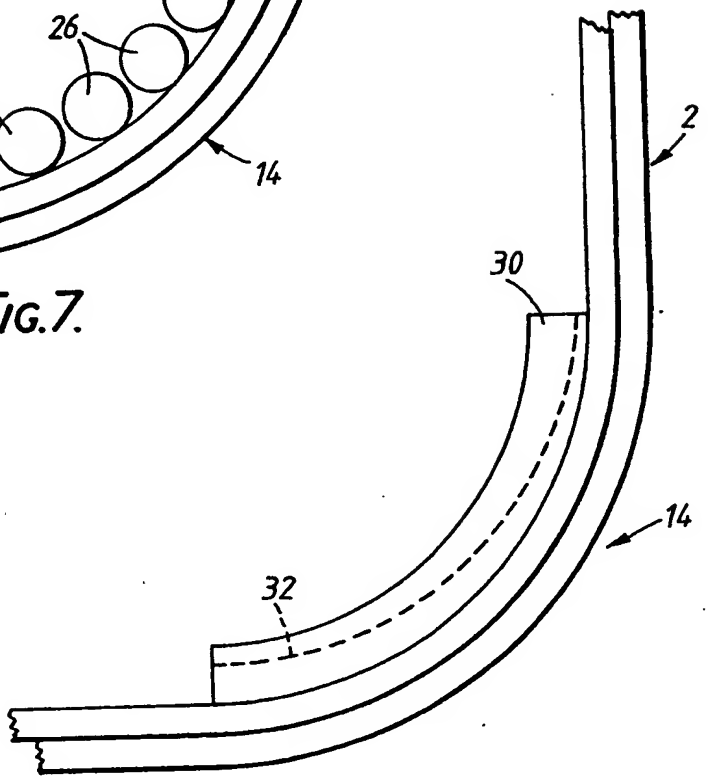

FIG. 8.

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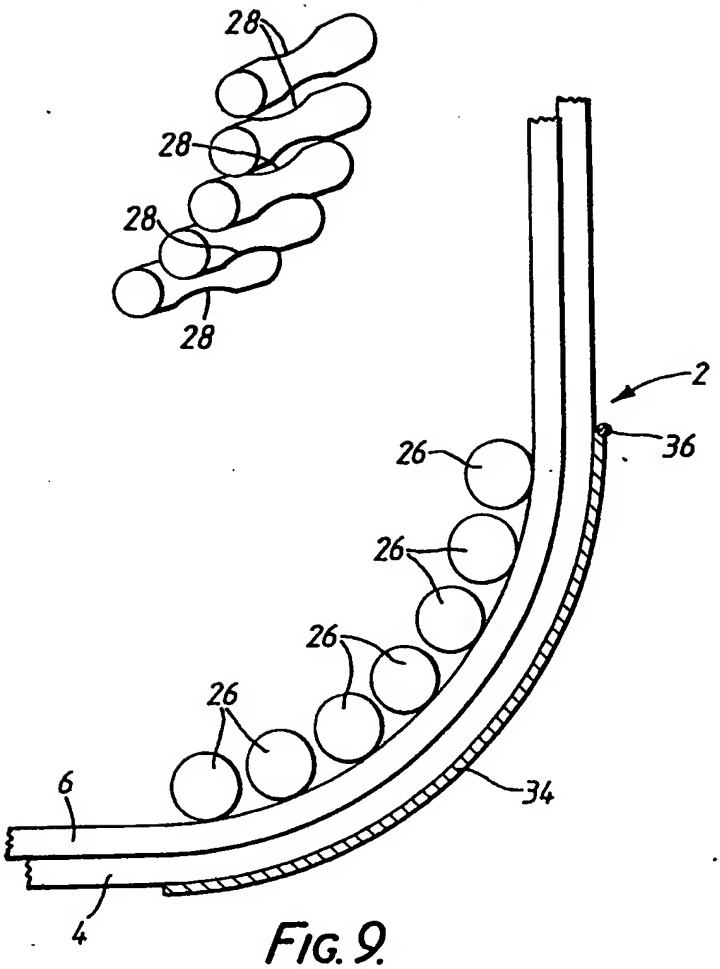

FIG. 9.

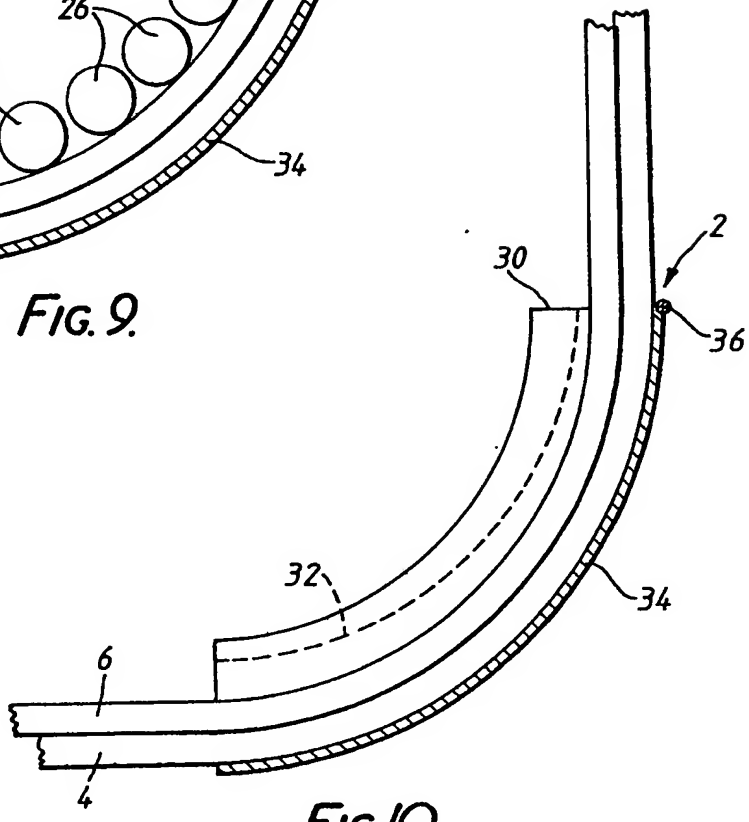

FIG. 10.

SPECIFICATION

Apparatus for elevating bulk material

This invention relates to apparatus for elevating bulk material.

Apparatus for elevating bulk material is well known. Traditionally, such apparatus has employed a plurality of buckets or paddles but then the feed employing the buckets or paddles is intermitent and vibration of the buckets or paddles as they are elevated through the apparatus can cause friable bulk material to become adversely degraded. If the bulk material is in powder form, the vibration causes the powdered material to escape in clouds from the apparatus and apart from the loss of material, unwanted dirt and dust can be created. Furthermore, if the bulk material is hydroscopic then the material often becomes wet and adheres to the buckets or paddles. This usually means that the entire apparatus has to be periodically stopped and cleaned. Such maintenance of the apparatus is both inconvenient, time consuming and expensive.

An attempt to deal with the problem has been made in PCT patent application number PCT/GB84/00131, international publication number W084/04084. The apparatus illustrated in the drawings of the PCT patent application will work with certain bulk material but not with other bulk materials. For example if the bulk materials are too powdery, then loss of bulk material from the formed vertical duct occurs. Also, if the bulk material is friable, then damage is done to the material. Furthermore, apparatus has been built according to the drawings of the PCT patent application and the vertical duct was held together by skids as suggested in the said patent application in order to endeavour to ensure that the duct remained closed whilst it was in the vertical position, in order to prevent loss of powdered material. The pressure exerted by the skids on the two belts forming the duct was so great that, whilst a model operated satisfactorily, working apparatus that was built was unable to operate because the motor driving the belts could not overcome the friction between the belts caused by the skids forcing the belts together to close the duct to prevent the loss of the powdered bulk material.

After very considerable experimentation with the apparatus illustrated in and constructed according to the PCT patent application, we established that the main problem was in the crushing of friable bulk materials and this crushing seemed to occur at the top and bottom bends adjacent the rollers 15, 19 respectively in the said PCT patent application. We established that the belt on the outside of the bends tended to bow inwardly, thereby reducing the cross sectional area of the duct at this point.

We have managed to provide a construction which overcomes the problem of the reduction of the duct cross sectional area as the belt passes through a bend.

Accordingly, this invention provides apparatus for elevating bulk material, which apparatus comprises an endless conveyor belt which is brought together over a part of its length with an elongate member to define a closed duct in which the bulk material is conveyed, the closed duct being such that it bends in a first bend in an upward direction for elevating the bulk material, the closed duct being such that the endless conveyor belt is situated on the outside of the first bend, at least one of the conveyor belt and the elongate member having tranversely extending walls which space the conveyor belt and the elongate member apart to define the closed duct, and the apparatus having a first concave surface at the first bend whereby inward deformation of the conveyor belt that is on the outside of the first bend is substantially compensated for by the first concave surface so that the cross sectional area of the closed duct remains substantially constant along the length of the closed duct and substantial narrowing of the closed duct in the area of the first bend is avoided.

The apparatus of the present invention avoids unwanted compression of the bulk material and it also avoids a general introduction of unwanted pressure into the entire apparatus as it is being used. This avoids or minimises on degradation of friable and compressible products. Furthermore, by avoiding a pressure build up, there is less tendency for fine particulate material to be forced sideways out of the duct. In the above mentioned apparatus as illustrated in the drawings of the said PCT patent application, a pressure is often induced which is greater than the sealing forces holding the conveyor belt together, causing fine particulate bulk material to leak from the apparatus. Because the conveyor has not been forced apart, there is no need to try and force it together again which would of course require further pressure and would thus be likely to cause further degradation of friable and compressible products.

If the cross sectional area of the closed duct was allowed to narrow, then the enclosed particulate material may tend to elevate at a speed which is less than that of the endless conveyor belt. This would in turn cause the enclosed bulk material prematurely to wear the endless conveyor belt. The apparatus of the present invention prevents this relative speed between the bulk material and the conveyor belt and thus avoids the premature wear of the conveyor belt.

Preferably, the closed duct is constrained to bend in a second bend in a horizontal or downwardly extending direction.

Where the closed duct is constrained to bend in the second bend, the apparatus of the

invention may be one in which the elongate member is an endless conveyor belt, and in which the apparatus has a second concave surface whereby the inward deformation of the conveyor belt that is on the outside of the bend is substantially compensated for by the second concave surface so that the cross sectional area of the closed duct remains substantially constant along the length of the closed duct and substantial narrowing of the closed duct in the area of the second bend is avoided.

Both of the conveyor belts may have transversely extending side walls.

Prior to the first bend, the walls of the conveyor belt that is on the outside of the first bend are preferably outermost walls.

The closed duct may be constrained to bend in the upward direction by first guide means situated on the inside of the first bend, the first guide means having the first concave surface.

The closed duct may be constrained to bend in the horizontal or downwardly extending direction by second guide means situated on the inside of the second bend, the second guide means having the second concave surface.

The first guide means may be a drum having the concave surface. Alternatively, the first guide means may be a plurality of rollers, each of the rollers having concave surfaces which combine to form the concave surface. As a still further alternative, the first guide means may be a curved sheet of material having the concave surface.

The first concave surface may have a plurality of curved portions of different radius of curvature. The various portions of the curved surface may however have the same radius of curvature if desired. Where a plurality of rollers are employed, the rollers may be in groups and each group of rollers may have a different radius of curvature than other rollers in other groups.

The second guide means may be similarly constructed as the first guide means. Thus, the second guide means may be a drum having the second concave surface. Alternatively, the second guide means may be a plurality of rollers, each of the rollers having concave surfaces which combine to form the concave surface. Still further, the second guide means may be a curved sheet of material having the second concave surface.

As in the case of the first concave surface, the second concave surface may have a plurality of curved portions of different radius of curvature. The curved portions may however have the same radius of curvature if desired.

Preferably, the first and the second guide means are of the same construction in the same piece of apparatus but they may be different if required.

The apparatus of the invention may include first constraining means, the first constraining means being situated on the outside of the first bend of the closed duct and such that it presses on the outside of the conveyor belt to cause the side walls to stay in sealing contact with the conveyor belt against which they abut.

The first constraining means may be a curved sheet of material. Alternatively, the first constraining means may be a plurality of constraining rollers arranged to define a curved path. Still further, the first constraining means may comprise an arrangement of constraining rollers and one or more curved sheets of material, the arrangement defining a curve.

The apparatus of the invention may also be such that means are provided to close the duct in its vertical position to prevent loss of bulk material in fine particulate form during operation of the apparatus, without causing the undue friction which was found as mentioned above in the apparatus constructed in accordance with the teaching of the said PCT patent application. Accordingly, the apparatus of the present invention may include second constraining means, the second constraining means being situated adjacent both sides of the closed duct as it extends in the upward direction.

The second constraining means may comprise a pair of rollers arranged on both sides of the closed duct as it extends in the upward direction. The rollers on one side of the closed duct are preferably offset from the rollers on the other side of the closed duct, thereby causing the closed duct to snake backwards and forwards as it extends in the upward direction. This snaking is not necessary but it tends to give a greater seal than without using the snaking.

Generally, the second constraining means does not have to exert exessive pressure on the belt, because the constant cross sectional area of the duct prevents unwanted extra pressure in the duct which would tend to force the duct open.

If desired, the second constraining means may be a pair of opposing plates. As a further alternative, the second constraining means may comprise two pairs of elongate members, the two pairs of elongate members acting one on each side of the closed duct.

The elongate member may be a static bent sheet of material.

The first bend will usually extend through substantially 90° but it may extend through other angles if desired.

Similarly, the second bend will usually extend through substantially 90° but it may extend through other angles if desired.

Embodiments of the invention will now be described solely by way of example and with reference to the accompanying drawings in which:

Figure 1 is a side elevation of a bottom bend in known apparatus for elevating bulk material, the said known apparatus being of the type shown in the said PCT patent application;

Figure 2 is a sectional view of the arrow B shown in Fig. 1;

Figure 3 is a part sectional view on the arrow A shown in Fig. 1;

Figure 4 is a side elevation of the bottom bend of apparatus for elevating bulk material in accordance with the invention, the apparatus having first guide means in the form of a drum having a concave surface.

Figure 5 is a sectional view on arrow B shown in Fig. 4;

Figure 6 is a part sectional view on arrow A shown in Fig. 4;

Figure 7 shows the first bend with first guide means in the form of rollers, the rollers being an alternative to the drum guide means shown in Figs. 4 to 6;

Figure 8 shows the first bend with first guide means in the form of a curved sheet of material;

Figure 9 shows the first bend and is like Fig. 7 but shows the presence also of first constraining means in the form of a curved sheet of material; and

Figure 10 shows the first bend and is like Fig. 8 but shows also the first constraining means shown in Fig. 9.

Referring to Figs. 1 to 3, there is shown part of apparatus 2 for elevating bulk material. The bulk material can be any type of bulk material including friable and compressible products such for example as soap powder. The apparatus 2 comprises an endless conveyor belt 4 which is brought together over part of its length with an elongate member in the form of a second endless conveyor belt 6. The belts 4, 6 define a closed duct 8 as shown. More specifically, the belt 4 has a pair of outstanding side walls 10 which extend between side walls 12 which depend from the belt 6.

As shown in Fig. 1, the duct 8 is such that it bends in a first bend 14 in an upward direction for elevating the bulk material. The belt 4 is situated on the outside of the first bend 14 as shown.

The belts 4, 6 bend around the periphery 16 of a drum 18. The drum 18 rotates about an axis 20.

Fig. 2 illustrates the normal cross sectional area of the duct 8. By comparing Fig. 2 with Fig. 3, it will be seen that the cross sectional area of the duct 8 is reduced as shown in Fig. 3, and Fig. 3 shows the cross sectional area of the duct 8 in the region of the first bend 14. The reduction of the cross sectional area of the duct 8 as shown in Fig. 3 will result in a crushing of friable bulk materials. The friable bulk materials will thus be adversely degraded. In the case of fine particulate materials, a pressure build up in the system may result in the belts 4, 6 being forced apart so that the side wall 10 no longer seals against the belt 6, and the fine particulate material escapes from between the side walls 10, 12, thereby resulting in a loss of particulate material and often in the formation of much dirt and dust. Still further, as the bulk material tries to pass through the restricted cross sectional area around the first bend 14, the belts 4, 6 may tend to travel faster than the bulk material. This relative slipping can in turn cause the bulk material prematurely to wear the belts 4, 6.

Referring now to Figs. 4 to 6, similar parts as in Figs. 1 to 3 have been given the same reference numerals and their precise construction and operation will not again be given. In Fig. 6, it will be seen that the periphery 16 of the drum 18 is provided with a concave surface portion 22. The drum 18 acts as first guide means and the concave surface portion 22 has the same radius as curvature as the radius of curvature on the inwardly deformed concave surface portion 24 of the belt 4. Thus, the duct 8, although varying slightly in shape, remains of substantially uniform cross section around the first bend 14. Thus there is no extra pressure applied on the bulk material as it passes around the first bend 14 and there is no extra pressure build up in the belt system due to the bend 14.

Although not shown in the drawings for simplicity, the apparatus 2 will normally be such that the belts 4, 6 will continue their vertical run as shown in Fig. 4 and this vertical run will then bend in a second bend (not shown). The second bend may extend in a horizontal or downward direction but it will usually extend through 90° similarly as the illustrated first bend 14. The arrangement illustrated in Figs. 4 to 6 and in particular the provision of the concave surface portion 22 on the drum 18 may be repeated on the inside of the second bend.

Referring now to Fig. 7, there is shown another type of first guide means. This type of first guide means comprises a plurality of rollers 26. Each roller 26 is provided with its own concave surface 28. All the concave surfaces 28 combine to form one single large concave surface equivalent to the concave surface portion 22 shown for the drum 18. The individual concave surfaces 28 may all be of the same or a different radius of curvature but, usually, the rollers 26 will be in groups of rollers 26 and all the rollers in any one group of rollers will be of the same radius of curvature, the different groups of rollers having different radiuses of curvature.

Referring now to Fig. 8, the first bend 14 is again shown but this time the rollers 26 have been replaced by first guide means in the form of a curved sheet 30. The curved sheet 30 may be formed of any suitable material

such for example as a metal, a plastics material or even wood. The curved sheet has a concave surface 32 indicated by the broken lines in Fig. 8 and this concave surface 32 will correspond generally to the concave surface portion 22 of the drum 18 as shown in Fig. 6.

Referring now to Fig. 9, there is shown apparatus 2 similar to that shown in Fig. 7. The apparatus 2 shown in Fig. 9 is however provided with first constraining means in the form of a curved sheet 34. The curved sheet 34 can be made of the same or a different material to the curved sheet 30. The curved sheet 34 may be secured in position by a fixing pin 36.

Fig. 10 shows apparatus similar to that shown in Fig. 8 but with the provision of the curved sheet 34 held in position by the fixing pin 36. In Figs 7–10, the cross sectional shape of the duct is usually the same as that of the duct 8 shown in Fig. 6.

It is to be appreciated that the embodiments of the invention described above with reference to the accompanying drawings have been given by way of example only and that modifications may be effected. Thus, for example, the belt 6 shown in Fig. 1 could be in the form of a static bent sheet of material. The first constraining means in the form of the curved sheet 34 shown in Figs. 9 and 10 could be replaced by a plurality of constraining rollers arranged to define a curved path, or by the combination of an arrangement of constraining rollers and one or more sheets of material, the arrangement defining the required curved. In the case where the apparatus 2 has a top bend, then the first constraining means may also be situated on the outside of the top bend.

The apparatus 2 may include second constraining means situated adjacent both sides of the closed duct 8 as it extends in the vertical direction as shown in Fig. 4. The second constraining means may comprise a plurality of rollers arranged on both sides of the closed duct as it extends in the upward direction. Preferably, the rollers on one side of the closed duct are offset from the rollers on the other side of the closed duct 8, thereby causing the closed duct 8 to snake backwards and forwards as it extends in the upwards direction. This snaking gives a good sealing effect between the side walls 10,12. As an alternative to employing a plurality of rollers as the second constraining means, the second constraining means may be formed by a pair of opposing plates or by two pairs of elongate members, the two pairs of elongate members acting one on each side of the closed duct 8.

CLAIMS

1. Apparatus for elevating bulk material, which apparatus comprises an endless conveyor belt which is brought together over a part of its length with an elongate member to define a closed duct in which the bulk material is conveyed, the closed duct being such that it bends in a first bend in an upward direction for elevating the bulk material, the closed duct being such that the endless conveyor belt is situated on the outside of the first bend, at least one of the conveyor belt and the elongate member having traversely extending walls which space the conveyor belt and the elongate member apart to define the closed duct, and the apparatus having a first concave surface at the first bend whereby inward deformation of the conveyor belt that is on the outside of the first bend is substantially compensated for by the first concave surface so that the cross sectional area of the closed duct remains substantially constant along the length of the closed duct and substantial narrowing of the closed duct in the area of the first bend is avoided.

2. Apparatus according to claim 1 in which the closed duct is constrained to bend in a second bend in a horizontal or downwardly extending direction.

3. Apparatus according to claim 2 in which the elongate member is an endless conveyor belt, and in which the apparatus has a second concave surface whereby the inward deformation of the conveyor belt that is on the outside of the bend is substantially compensated for by the second concave surface so that the cross sectional area of the closed duct remains substantially constant along the length of the closed duct and substantial narrowing of the closed duct in the area of the second bend is avoided.

4. Apparatus according to claim 3 in which both of the conveyor belts have the traversely extending walls.

5. Apparatus according to claim 4 in which prior to the first bend, the walls of the conveyor belt that is on the outside of the first bend are the outermost walls.

6. Apparatus according to any one of the preceding claims in which the closed duct is constrained to bend in the upward direction by first guide means situated on the inside of the first bend, the first guide means having the first concave surface.

7. Apparatus according to claim 3 and claim 6 in which the closed duct is constrained to bend in the horizontal or downwardly extending direction by second guide means situated on the inside of the second bend, the second guide means having the second concave surface.

8. Apparatus according to claim 6 or claim 7 in which the first guide means is a drum having the concave surface.

9. Apparatus according to claim 6 or claim 7 in which the first guide means are a plurality of rollers, each of the rollers having concave surfaces which combine to form the concave surface.

10. Apparatus according to claim 6 or claim 7 in which the first guide means is a curved sheet of material having the concave surface.

11. Apparatus according to any one of the preceding claims in which the first concave surface has a plurality of curved portions of different radius of curvature.

12. Apparatus according to claim 7 or to claim 7 and any claim when appendant to claim 7 in which the second guide means is a drum having the second concave surface.

13. Apparatus according to claim 7 or to claim 7 and any claim when appendant to claim 7 in which the second guide means are a plurality of rollers, each of the rollers having concave surfaces which combine to form the concave surface.

14. Apparatus according to claim 7 or to claim 7 and any claim when appendant to claim 7 in which the second guide means is a curved sheet of material having the second concave surface.

15. Apparatus according to claim 7 or to claim 7 and any claim when appendant to claim 7 in which the second concave surface has a plurality of curved portions of different radius of curvature.

16. Apparatus according to claim 7 or to claim 7 and any claim when appendant to claim 7 in which the first and the second guide means are of the same construction.

17. Apparatus according to any one of the preceding claims and including first constraining means, the first constraining means being situated on the outside of the first bend of the closed duct and such that it presses on the outside of the conveyor belt to cause the side walls to stay in sealing contact with the conveyor belt against which they abut.

18. Apparatus according to claim 17 in which the first constraining means is a curved sheet of material.

19. Apparatus according to any one of claims 1 to 17 in which the first constraining means are a plurality of constraining rollers arranged to define a curved path.

20. Apparatus according to any one of claims 1 to 17 in which the first constraining means comprises an arrangement of constraining rollers and one or more curved sheets of material, the arrangement defining a curve.

21. Apparatus according to any one of the preceding claims and including second constraining means, the second constraining means being situated adjacent both sides of the closed duct as it extends in the upward direction.

22. Apparatus according to claim 21 in which the second constraining means comprises a plurality of rollers arranged on both sides of the closed duct as it extends in the upward direction.

23. Apparatus according to claim 22 in which the rollers on one side of the closed duct are offset from the rollers on the other side of the closed duct, thereby causing the closed cut to snake backwards and forwards as it extends in the upward direction.

24. Apparatus according to any one of claims 1 to 21 in which the second constraining means is a pair of opposing plates.

25. Apparatus according to any one of claims 1 to 21 in which the second constraining means comprises two pairs of elongate members, the two pairs of elongate members acting one on each side of the closed duct.

26. Apparatus according to claim 1 or claim 2 in which the elongate member is a static bent sheet of material.

27. Apparatus according to any one of the preceding claims in which the first bend extends through substantially 90°.

28. Apparatus according to any one of the preceding claims in which the second bend extends through substantially 90°.

29. Apparatus for elevating bulk material, substantially as herein described with reference to Figs. 4 to 10 of the accompanying drawings.

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